till lately passed for gospel. Destruction may be useful, but it is a low kind of work. We are just about where Boyle was in the seventeenth century. We can dispose of alchemy, but we can not make more than a quasi-chemistry. We are awaiting our Priestley and our Mendeléeff. In truth it is not these wider aspects of genetics that are at present our chief concern. They will come in their time. The great advances of science are made like those of evolution, not by imperceptible mass-improvement, but by the sporadic birth of penetrative genius. The journeymen follow after him, widening and clearing up, as we are doing along the track that Mendel found.

WILLIAM BATESON

MORPHOLOGY OF THE BACTERIA (VIBRIO AND SPIRILLUM), AN EARLY RESEARCH.[1]*—THE INTESTINAL FLORA*

BIOLOGY presents few more fascinating pictures than that which portrays the early development of microscopic research in relation to what is now recognized as the science of bacteriology, and in our anxiety to pursue the utilitarian side of the subject it behooves us not to forget the work of the early pioneer naturalists who gave us the first glimpse of the foundation stones of what has come to be one of the most important departments of biological science. Did time permit, I should like to dwell in detail upon the early work of Leeuwenhoek,[2] Müller,[3] Bory-de Saint Vincent, and later Ehrenberg[4] and Dujardin,[5] respectively, 1839–1841—the latter of whom were the first to attempt a systematic classification of the bacteria—made doubly difficult—for until this time and for some years later these microorganisms or animalcula, as they were then termed, were included among the Infusoria and were so classified.

Authorities have credited Perty, 1852, and Robin, 1853, as the first observers to suggest a vegetal nature of these organisms. In a recent review of the scientific correspondence between Joseph Leidy and Spencer F. Baird, late secretary of the Smithsonian Institution, in 1847–1849, a letter from Leidy to Baird in 1847 attracted my attention. In it he observes that he is in the midst of an investigation upon the structure of the alimentary canal and the chemical processes of digestion, and desires a series of insects from the mountainous regions of Pennsylvania, where Baird then lived, upon which to pursue his investigation, the results of which he would communicate later through a report to the Philadelphia Academy of Natural Science.

Curious to observe the character of this research, upon reference to the Academy's Proceedings, we find in *October, 1849,* Leidy presented a paper with the following preamble:

> From the opinion so frequently expressed that contagious diseases and some others might have their origin and reproductive character through the agency of cryptogamic spores, which, from their minuteness and lightness, are so easily conveyed from place to place through the atmosphere, by means of the gentlest Zephyr, or even the evaporation continually taking place from the earth's surface; and from the numerous facts already presented of the presence of cryptogamic vegetation in many cutaneous diseases and upon other diseased surfaces, I was led to reflect upon the possibility of plants of this description existing in healthy animals, as a natural condition; or at least apparently so, as in the case of entozoa. Upon considering that the conditions essential to vegetable growth were the same as those indispensable to animal life, I felt convinced that entophyta would be found in healthy living animals, as well, and probably as frequently, as entozoa. The constant presence of mycodermatoid filaments growing upon the human teeth, the teeth of the ox, sheep, pig, etc., favored this idea, and accordingly

[1] The research with which this paper deals came to light during a review of the work performed by various authors upon the intestinal flora of men and the lower orders of animals, and it is hoped that the subject will prove of sufficient interest to justify the writer in bringing it to the attention of the Society of American Bacteriologists.

[2] *Transactions Royal Society,* 1675–1683.

[3] "Animalia Infusoria," 1773.

[4] "Die Infusionsthierchen als Valkom Organism," 1838; *Verhandl. der Berl. Acad.,* 1839.

[5] "Historie Naturelle des Zoophytes," 1841.

I instituted a course of investigation, which led to the discovery of several well-characterized forms of vegetable growth, of which, at present, I will give but a short description, for the purpose of establishing priority, and propose giving a more detailed account of them, with figures, in the second volume of the journal.

Then follows a description of various new genera and species of cryptogamic vegetation, growing upon the basement membrane of the small intestine of the myriapod *Julus marginatus* (Say), and upon the exterior of the entozoa—*Acaris infecta,* infesting this insect—another new genera of entophyta allied to the mycodermata. He further observes:

Centipede, Millipede, Thousandleg

The three genera of entophyta of which I have now spoken are all so constantly found in *Julus marginatus* that I look upon it as a natural condition, and should I hereafter meet with an individual without them, I will consider it a rare exception, because in one hundred and sixteen individuals which I have examined during the past thirteen months, in all seasons, and at all ages and sizes of from one up to three inches of the animal, I have invariably found them. It can not be supposed that these are developed and grow after death, because I found them always immediately upon killing the animal. Whilst the legs of fragments of the animals were yet moving upon my table, or one half of the body even walking, I have frequently been examining the plants growing upon part of the intestinal canal of the same individual. And upon the entozoa these entophyta will be frequently found growing, whilst the former are actively moving about. I found among others an ascaris three lines long, which had no less than twenty-three individuals of *Enterobrus* (parasitic), averaging a line in length, besides a quantity of the other two genera, growing upon it, and yet it moved about in so lively a manner that it did not appear the least incommoded by its load of vegetation. This specimen I have preserved in a glass cell in Goadby's solution, and exhibit it to the academy.

The genus *Julus* is an extensive one, and its species are found in all the great parts of the globe, and as their habits are the same, the conditions for the production of the entophyta will be the same, and I think I do not go too far when I say they will be constantly found throughout the genus in any part of the world, so that naturalists and other, may, upon examination, readily verify or contradict the statements which I have this evening presented.

Then follow to us these interesting observations:

From these facts we may perceive that we may have entophyta in luxurious growth within living animals without affecting their health, which is further supported by my having detected mycodermatoid filaments in the cœcum of six young and healthy rats, examined immediately after death, although they existed in no other part of the body. These filaments were minute, simple and inarticulate, measuring from 1/5,000 to 1/1,428 inch in length by 1/16,000 of an inch in breadth. With them were also found two species of *Vibrio.*

Even those moving filamentary bodies belonging to the genus *Vibrio,* are of the character of algous vegetation. Their movement is no objection to this opinion, for much higher confervæ, as the Oscillatorias, are endowed with inherent power of movement, not very unlike that of the *Vibrio,* and indeed the movement of the latter appears to belong to one stage of its existence. Thus, in the toad (*Bufo americanus*), in the stomach and small intestine, there exist simple, delicate, filamentary bodies, which are of three different kinds. One is exceedingly minute, forms a single spiral, is endowed with a power of rapid movement, and appears to be the *Spirillum undula* of Ehrenberg; the second is an exceedingly minute, straight and short filament, with a movement actively molecular in character, and is probably the *Vibrio lineola* of the same author; the third consists of straight, motionless filaments, measuring 1/1,125 inch long by 1/15,000 broad; some were, however, twice or even thrice this length; but then I could always detect one or two articulations, and these, in all their characters, excepting want of movement, resemble the *Vibrio.* In the rectum of the same animal, the same filamentary bodies are found, with myriads of *Bodo intestinalis;* but the third species, or longest of the filamentary bodies, have increased immensely in numbers, and now possess the movement peculiar to the *Vibrio lineola,* which, however, does not appear to be voluntary, but reactionary; they bend and pursue a straight course, until they meet with some obstacle, when they instantly move in the opposite direction, either extremity forward.

These observations were published in 1849, and it is of interest to note that ten years

elapsed before M. Davaine in 1859[6] made the same observation in almost identical language suggesting the vegetal nature of the *Vibrio*—its alliance to the Algæ and especially the Confervæ.

Leidy continues in the same number of the Proceedings:

But it must not be understood that these facts militate against the hypothesis of the production of contagious diseases through the agency of cryptogamia. It is well established that there are microscopic cryptogamia capable of producing and transmitting disease, as in the case of the Muscardine, etc., as that there are innocuous and poisonous fungi. In many instances it is difficult to distinguish their character, whether as cause or effect, as upon diseased surfaces, in Tinea capitis, apthous ulcers, etc. In a post-mortem examination, in which I assisted Dr. Horner,[7] a few weeks since, 28 hours after death, in moderately cool weather, we found the stomach in a much softened condition. In the mucus of the stomach, I detected myriads of mycodermatoid filaments, resembling those growing upon the teeth; simple, floating, inarticulate and measuring from 1/7,000 to 1/520 of an inch in length by 1/25,000 of an inch in breadth. It is possible that they may have been the cause of the softened condition; but I would prefer thinking that swallowed mycodermatoid filaments from the teeth, finding an excellent nidus in the softening stomach, rapidly grew and reproduced themselves. In the healthy human stomach these do not exist.

In the stomach of a diabetic patient, I found so very few that they probably did not grow there, but were swallowed in the saliva.

A note is appended to this report:

Note:—Since the above went to press, Dr. Leidy announced to the academy that he had discovered two new species of the entophyte *Enterobrus;* one of them, *E. spiralis,* growing in the small intestine *Julus pusillus;* the other, *E. attenuatus,* growing more or less profusely with a second species of *Cladophytum, C. clavatum,* in the ventriculus of the coleopterous insect, *Passalus cornutus. Thus has been established the law "that plants may grow in the interior of the healthy animal as a normal condition," and a new field has been presented for the investigation of the Cryptogame-naturalist.* (See forthcoming number of the Proceedings.)[8]

Also in December, 1849, appears:

Besides the foregoing I have found numerous free or floating entophyta in the contents, usually of the *posterior part of the alimentary canal, in mammalia, aves, reptilia, pisces, mollusca, insecta, etc.* These, at present, I do not feel at liberty to describe as new or peculiar, from my want of acquaintance with cryptogamic botany. A number of them, I have no doubt, if not peculiar, at least continue to grow luxuriantly in the intestinal canal; such are various Mycoderma, etc.; others very probably are swallowed with the food, and pass from the intestinal canal unchanged. Numerous drawings of these I exhibit to the Academy, and purpose leaving them to future investigation, or to the consideration of cryptogamic botanists, being a field well worthy of their researches. I also have a number of others, the character of which is peculiarly entophytic; but these I have not yet studied out nor figured, but hope to present descriptions of them to the academy in a very short time.

These researches upon the morphology and vegetal nature of the *Vibrio* and *Spirillum;* the suggestion of polymorphism, much dilated upon by later observers; the enunciation of a new law of the general existence of a parasitic intestinal flora of cryptogamic vegetation existing throughout the animal kingdom as a normal condition; the pathological significance of the presence of germs upon diseased surfaces, as to cause or effect; the suggestion of the inherent resistance of healthy living tissues to certain forms of vegetal parasites, are of more than historic interest.

As bearing upon the various types of microscopes then in use (1849). It is of interest to note in the last paper, he describes for the first time muscular striæ in the posterior cell, and later the anterior cell, of a new species of gregarina, determining its animality[9] which

[6] *Rend. Comp.,* Paris, 1859, V., 58, 59; also "Traite des Entozoaries," Paris, 1860.

[7] W. E. Horner, professor of anatomy, University of Pennsylvania, 1849.

[8] "A Flora and Fauna within Living Animals," Smithsonian Institution, 1851.

[9] "Gregarina Dufox," *Proc. A. N. S.,* 1849 See also "Collected Researches in Helminthology and Parasitology," by Joseph Leidy, 1823–91, Smithsonian Institution, 1904.

had been previously denied by *Creplin*[10] and *von Seibold.*[11]

Leidy, in his monograph on the Gregarina, published this year, attributes the failure on the part of these investigators to note the presence of muscular striæ, to the inferiority of the microscopes used on the continent of Europe compared with those in use in England and America (1849).

Finally in a third paper published February, 1850, *Philadelphia Proc. Acad. Nat. Sci.,* Leidy writes it was now eighteen months since he had sought for Entophyta within living animals, having been previously impressed with the belief of their existence upon reflecting upon the essential conditions of life. Four months since he exhibited to the Academy numerous drawings and specimens of Entophyta obtained from living animals; he now exhibited others.

The essential conditions of life are five in number, viz., a germ, nutritive matter, air, water and heat. The four latter undoubtedly exist in the interior of living animals, animal or entozoa germs also are well known to exist, and it was rendered extremely probable that vegetable germs would also exist, and with them all the conditions necessary to vegetable growth. Plants have been very frequently observed growing upon the exterior of animals, and less frequently upon the interior, most usually upon diseased surfaces, but the growth of such parasites had not been pointed out as a normal and common condition as in the case of entozoa.

He next reviewed the theory of generation. He inclines to the opinion that sexual elements are absolutely necessary for the perpetuation of germs. He considered the *alternation* of generation in certain animals no objection to the law, for after successive developments an admixture of sexual elements is observed to be necessary. The reproduction among Cryptogamia may probably often exhibit phenomena analogous to the *alternation* of generation of animals, but universally he thinks it will be discovered that a true sexual mixture takes place in every species of these plants at some period of their life. According to the observations of Schimper, it is necessary among the mosses. From an observation made by Klencke upon a fungus which grew upon a diseased surface, Dr. Leidy thinks that sexual admixture would be discovered to take place in the mycelium. In numerous instances it had been observed among the Algæ. He stated he thought he had noticed the process in *Achyla prolifera,* and gave a description of the phenomena. He finally considers that science is on the eve of demonstrating the existence of a law "that an admixture of sexual elements is necessary for the perpetuation of specific life germs."

He then exhibited numerous elaborate drawings of new entophyta observed growing in the ventriculus of *Passalus cornutus,* a remarkable one growing in a honey-like liquid in the proventriculus of the larva of *Arctia Isabella,* another from *Acheta abbreviata,* etc. He remarked that when such plants were found in animals they were usually very abundant.

Dr. Leidy then stated that *very slight modifications in the five essential conditions of life were sufficient to produce the vast variety of living beings upon the globe.* As an instance, he mentioned he had lying upon his table a saucer with a cork bottom, in which lay a partially dissected *Passalus cornutus* half immersed in water. Two days afterwards he noticed on the part of the insect above the water a quantity of Mucor mucedo growing, and from the part within the water numerous fine, stiff filaments, which upon examination proved to be *Achyla prolifera;* upon the cork around the insect grew a third genus, consisting of fine cottony filaments, which were articulated, of which he exhibited a drawing; and upon the insect at the surface of the water, but not within the latter, grew a fourth genus, of which he also exhibited a drawing.

He also stated that he had had the good fortune of observing in a single morning all the stages of development of *Achyla prolifera* growing from some individuals of *Ascarides* which had been lying in a dish of water for a few days.

[10] *Wiegmann's Archiv,* 1846, 1 Band, S. 157.

[11] *Wiegmann's Archiv,* 1838, 2 Band, S. 308.

In reply to some remarks made by members, Dr. Leidy said he could not admit the doctrine of spontaneous generation,[12] but rather modifications in the essential conditions of life favorable to the development of different and always preexisting germs derived from a parent.

It is but natural that these researches should lead to a discussion of the hypothesis of spontaneous generation and the origin of species. On these further researches I should like to dwell, bearing, as they do, upon the germ theory, but I fear I have already taxed your patience, so I must forbear.

From these published researches, in any historical review of the history of bacteriology, the usual accepted date of Davaine's designation of the vegetal nature of these organisms, *Vibrio, Spirillum,* 1859, should be moved back at least another decade to 1849.

Joseph Leidy, Jr.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

The twelfth annual session of the South African Association for the Advancement of Science was held in Kimberley, Cape Province, during the week commencing Monday, July 6, under the presidency of Professor R. Marloth. There was the usual round of festivities and of visits to places of scientific or historic interest. The papers read numbered between forty and fifty. Dr. A. Ogg, professor of physics at Rhodes University College, Grahamstown, in his presidential address to Section A, dealt with some of the ideas in physical science which are under discussion at the present time in the light of recent research, and sought to bring under review some of our fundamental notions or principles, having regard to the fact that what mathematicians and physicists have long considered well established is now being uprooted and replaced by non-Newtonian mechanics based on the principle of relativity. In Section B the presidential address was given by Professor G. H. Stanley, of the Transvaal School of Mines and Technology, whose subject was "A Decade of Metallurgical Progress on the Witwatersrand." The greatest advances during the last ten years, he said, were in improving methods of carrying out the various stages of the extraction processes, the essentials remaining unchanged. In Section C, comprising the biological sciences and agriculture, the presidential address of Professor George Potts, of Grey University College, Bloemfontein, dealt with rural education. An evening discourse was delivered in the Kimberley City Hall by Professor E. H. L. Schwarz, on the Kimberley diamond pipes, the history of their discovery, and their relation to other South African volcanic vents. This lecture, like Professor Marloth's address as president of the association was illustrated by many lantern slides. The numerous slides exhibited by Professor Marloth were all hand colored, and constituted the most excellent collection representative of South African indigenous flora ever exhibited. At the conclusion of the president's address, Dr. Crawford, the association's senior vice-president, handed to him the South Africa medal (instituted by the British Association in 1905 in commemoration of its visit to South Africa during that year) and grant of £50 which had been conferred upon him in recognition of his eminent services to botanical science in South Africa during the last thirty years.

PACIFIC FISHERIES SOCIETY

On March 11 a meeting of those interested in the upbuilding and perpetuating of the great fisheries of the Pacific slope was held in Seattle, Wash., and it was decided to form a temporary organization of a society to be known as the Pacific Fisheries Society, and to hold a meeting later in the year for the pur-

[12] For experiments in connection with the theory of spontaneous generation, see "Flora and Fauna within Living Animals," Smithsonian Institution, 1851, *et al.,* published lectures before students of medical department, University of Pennsylvania, 1858 and 1859.

[1] Abridged from a report in *Nature.*